AN3218
Application note

Adjacent channel rejection measurements for the STM32W108 platform

1 Introduction

This application note describes a method which could be used to characterize adjacent channel rejection (ACR) on RF chips. It also compares different methods used by other manufacturers when quoting ACR performance.

Adjacent channel rejection (ACR) is an important parameter for any radio receiver. It is a measure of how well a receiver performs on its frequency channel when there is an interfering system in the vicinity operating on a nearby channel.

ACR is generally one of the parameters that is used to compare the performance of different RF ICs. However, different silicon vendors use different methods for measuring ACR, which may distort performance figures.

This application note presents a method used to measure ACR on its IEEE 802.15.4-2003 compliant ICs, and compares it against other methods.

1.1 Supported STM32W108xx kits

This document is applicable to the following STM32W108xx kits:

- STM32W108xx starter kit (part number: STM32W-SK)
- STM32W108xx extension kit (part number: STM32W-EXT)
- STM32W108xx low-cost RF control kit (part number: STM32W-RFCKIT)

2 Requirements

The IEEE 802.15.4-2003 standard specifies a minimum level of ACR that chips must meet.

It is defined as follows:

> *6.5.3.4 Receiver jamming resistance*
>
> *The minimum jamming resistance levels are given in Table 22. The adjacent channel is one on either side of the desired channel that is closest in frequency to the desired channel, and the alternate channel is one more removed from the adjacent channel. For example, when channel 13 is the desired channel, channel 12 and channel 14 are the adjacent channels, and channel 11 and channel 15 are the alternate channels.*

Table 1. Minimum receiver jamming resistance requirements for 2450 MHz PHY

Adjacent channel rejection	Alternate channel rejection
0 dB	30 dB

The adjacent channel rejection shall be measured as follows. The desired signal shall be a compliant 2450MHz IEEE 802.15.4 signal of pseudo-random data. The desired signal is input to the receiver at a level 3 dB above the maximum allowed receiver sensitivity given in 6.5.3.3. In either the adjacent or the alternate channel, an IEEE 802.15.4 signal is input at the relative level specified in Table 22. The test shall be performed for only one interfering signal at a time. The receiver shall meet the error rate criteria defined in 6.1.6 under these conditions.

Most 802.15.4 ICs exceed the standard's requirements by a long way.

The standard does not specify the filtering of the interferer signal, it only states that it should be 802.15.4 compliant, which means it must meet the spectral mask and error vector magnitude (EVM) specifications.

3 Interferer waveforms

For the ACR figures quoted in datasheets, the interferer signal is generated by using the arbitrary waveform generator mode of a signal generator, and constructing a near ideal 802.15.4 O-QPSK waveform containing pseudo-random symbols.

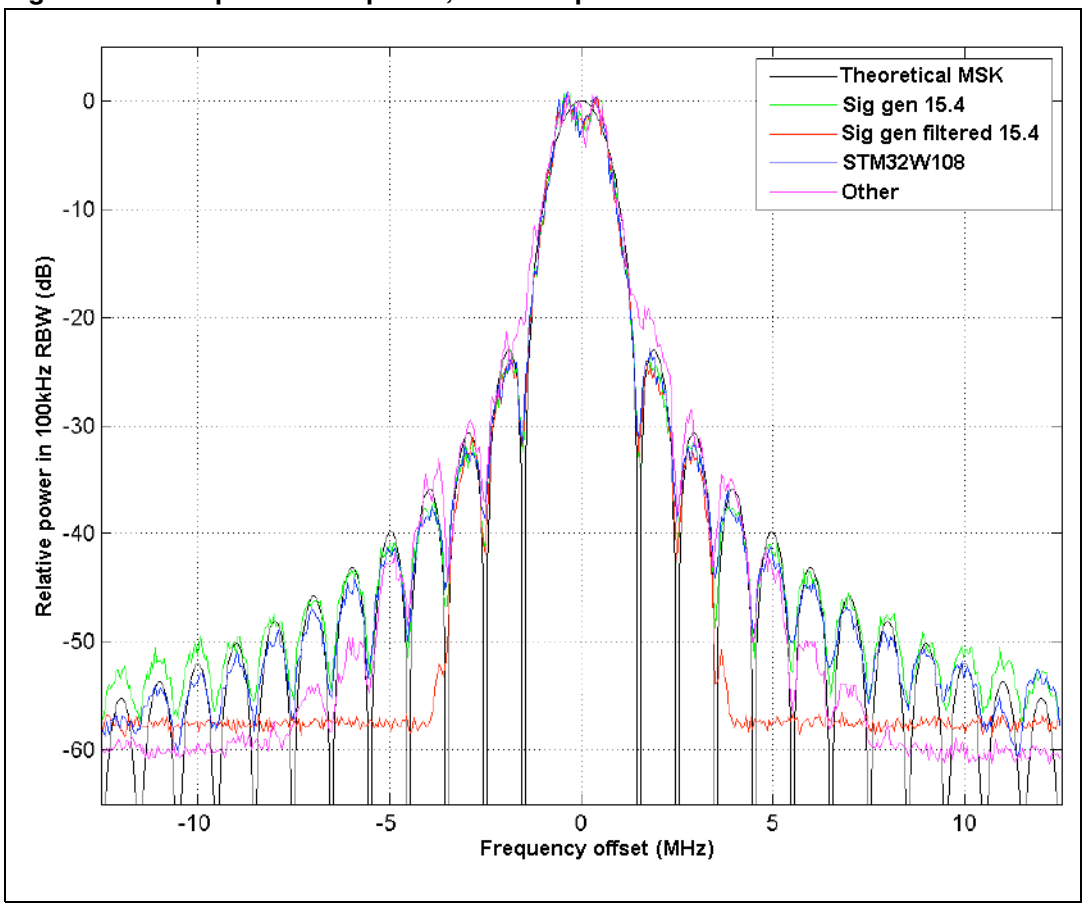
Other manufacturers use a heavily filtered IEEE 802.15.4-2003 signal to measure ACR. This has the result of removing all energy from the interferer's sidelobes that would fall in-band. This method creates such a signal by filtering the ideal signal prior to loading into a signal generator. The filter uses a 100 tap FIR with cutoff frequency at 3.5 MHz so that the 2nd (3 MHz) sidelobe is not attenuated, but the 3rd one (4 MHz) is almost completely removed. While this signal is IEEE 802.15.4-2003 compliant (it meets the EVM specified in the standard), it is not representative of any real implementation since this degree of filtering is not practical in real silicon.

Figure 1 and *Figure 2* show a comparison of 802.15.4 spectra produced by signal generators and 802.15.4 silicon.

Using an ideal signal source, ACR performance is ultimately limited by energy from an interfering signal that falls into the wanted channel bandwidth. *Figure 2* shows that at 5 MHz offset, the ideal and real silicon spectra are 42 dB below the wanted signal level in a 100 kHz bandwidth. A good receiver will have a 1.1 MHz bandwidth, and the integrated power in this bandwidth is –38 dBc at 5 MHz (1.1 MHz is the bandwidth of the matched filter for optimum signal reception, different receivers may have wider bandwidths than this). Therefore, if a receiver has an SNR requirement of 3 dB, then it cannot achieve an ACR of better than 35 dB. Any datasheet that quotes more than 35 dB for ACR is not using an ideal or even a representative 802.15.4 interferer signal. While some chips may be capable of higher rejection of the main signal lobe at 5 MHz, this is of little value since the in-band sidelobe level limits real system performance.

At 10 MHz, the receiver cannot achieve a rejection of better than 48 dB for an ideal 15.4 signal.

Figure 1. Comparison of spectra, 25 MHz span

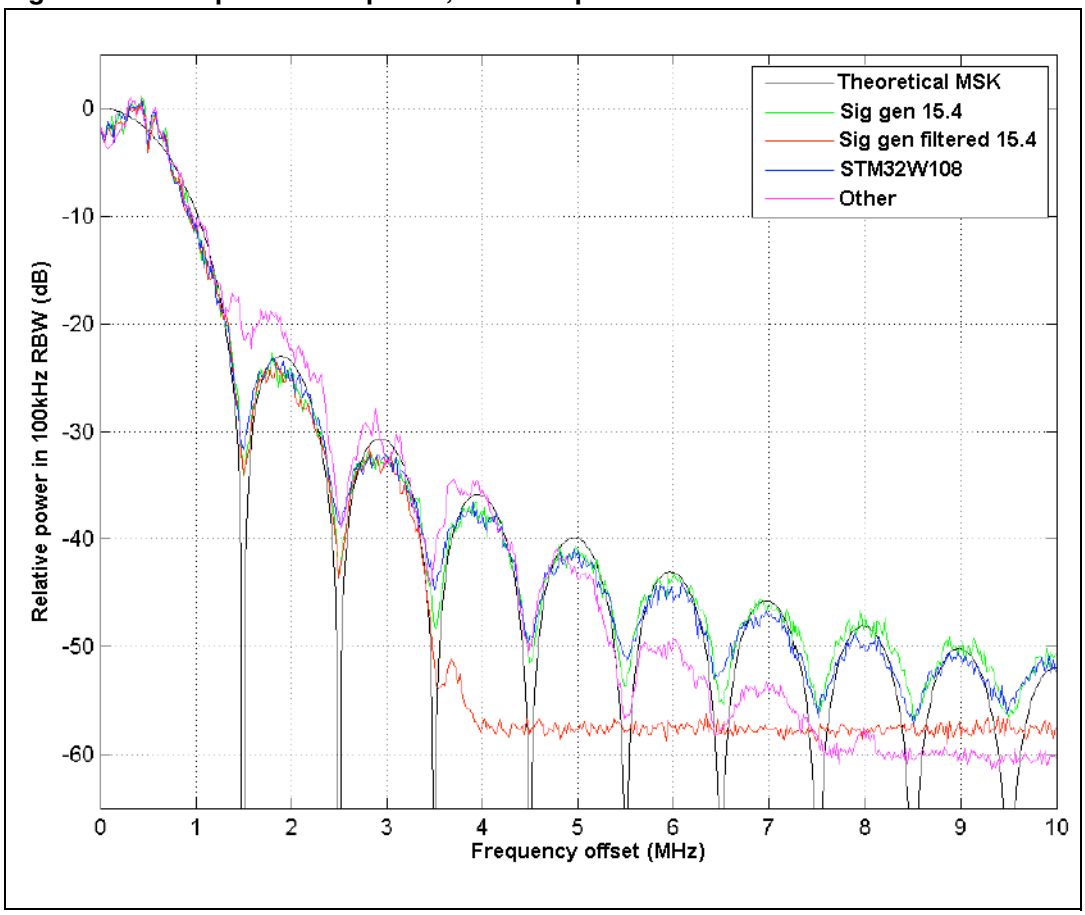


It can be seen that the heavily filtered 15.4 signal generated by the signal generator is not representative of either type of modulation technique, and therefore does not give a useful measure of real performance.

At 10 MHz there is a difference between the two modulation methods of about 10 dB. This means that the vector-modulated signal could show a better ACR if the receiver's own rejection is high enough. However, quoted alternate channel measurements should still use an ideal signal since a system designer cannot know what type of transmitter is used in the interfering node(s).

Note that the standard specifies using an 802.15.4 signal of pseudo-random data for the interferer. This is not the same as using a signal generator to generate an MSK signal with pseudo-random chips, although the effect on ACR is small. The difference between random MSK chips and random 15.4 symbols is the dip in the spectrum at 0 Hz offset.

Figure 2. Comparison of spectra, 10 MHz span



4 Co-channel measurements

It should also be noted that co-channel interference measurements should be made using a properly modulated IEEE 802.15.4-2003 signal, and not with an MSK signal with random chips. The MSK signal will look like noise to the receiver, whereas a co-channel IEEE 802.15.4-2003 signal may give worse performance as the receiver sees it as a valid signal.

5 Conclusion

Care must be taken when measuring adjacent and alternate channel rejection since the interferer signal characteristics greatly affect results. The only unambiguous interferer signal waveforms to use for IC comparison are an ideal 802.15.4 signal and a CW tone.

The use of a filtered 15.4 signal is not representative of a real world scenario, and is not well enough specified to ensure consistency between manufacturers.

After reading this document

If you have questions or require assistance with the procedures described in this document, contact STMicroelectronics support at www.st.com/stm32w.

6 Revision history

Table 2. Document revision history

Date	Revision	Changes
07-Sep-2010	1	Initial release.
04-Mar-2011	2	Changed web site address; added supported STM32W108xx kits.

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